



severe bed-sores, and a bad case of cystitis, and perhaps, later, pyelonephritis from a paralyzed bladder. This state of affairs, together with a parietic bowel, makes a picture that appeals to us all. What is the treatment best calculated to afford a chance for relief?

The first thing that suggests itself is the reposition of the fragments, and this can sometimes be done by the use of force—severe extension and counter-extension—under complete anaesthesia. This has been accomplished in some cases of fracture of the dorsal or lumbar region. After succeeding, the patient must still have extension continued, or a plaster jacket applied. A water- or air-bed is absolutely indicated. Any moving of the patient must be done with the greatest care, for the slightest twisting in the injured part may produce sudden and serious symptoms, if not death.

The urine must be watched and kept in the most aseptic condition possible, both by frequent and careful catheterizing and by irrigating the bladder.

I believe extension does little if any good, but can do a great amount of injury. A loose piece of bone, causing no trouble, may be forced by extension into the substance of the cord, and injure it beyond repair. Should extension remove or relieve a piece of bone already pressing on or embedded in the cord, it would be merely a case of good luck.

If a plaster jacket be applied after extension, it is certainly harmful, by its pressure upon the injured and paralyzed parts. In fact, I believe the results achieved by extension would have been the same had the patients been placed on air-beds and given perfect rest.

As to laminectomy, while the outlook in any case of fractured vertebræ is not encouraging, I firmly believe that where the paralysis is due to *pressure on the cord* from hæmorrhage, or a piece of bone, or a foreign body, we may look for relief by operation.

With the aid of the Röntgen rays, a change of opinion has taken place. With this valuable adjunct, the fracture can be definitely seen, and splinters of bone can be located, or

the bone pressing on the cord can be demonstrated with little trouble. In these cases of severe crushing injuries, and where we are almost certain that the cord is compressed or being injured by spiculæ of bone, operation is clearly indicated, and, to repeat what was just said, will often bring great relief, and sometimes permanently cure. To my mind nothing is more rational or natural than to remove a fragment or several fragments of bone that are pressing upon the cord. By the open treatment of these cases we can also remove any accumulations of blood, which are fertile sources of pressure and permanent paralysis. We do not hesitate to open the skull for a depressed fracture, or for paralysis, resulting from supposed rupture of the middle meningeal; and yet in the cord we have structures that are in most ways identical with the cranial contents; and why not do likewise for an injury similar in many respects, and no more dangerous to life?

The results obtained by various operators who have performed laminectomy for fractured spine have been encouraging. Experience has shown repeatedly that degeneration of the cord is rapid and progressive where pressure from bone, or other cause, is present and continuous. It has also been proven that the loss of blood during operation is not severe, nor does the escape of spinal fluid do any harm.

The back is not weakened by the loss of lamina and spinous processes. The number relieved certainly justifies operation. The upper half of the cord, when injured, offers little hope from operation, though benefit has been shown in reported cases by McCosh, Abbe, Munro, and Horsley.

Ordinary shock does not contraindicate operation, for the injury itself is producing the shock, laminectomy relieves the pressure, and consequently raises the body tone and helps restore the body heat. I believe all cases, if operated upon, should have it done within forty-eight hours, if not sooner, when the displacement is marked and diagnosis is almost a certainty. All open injuries of the cord call for active interference, for in these cases we may have infection, foreign bodies, or necrosis of the tissues; and operation permits care-

ful cleansing, removal of foreign particles, careful drainage, and possible ultimate recovery. Burrell (quoted from Keen) "has analyzed 168 cases of fractured spine, and has not only given up his earlier plan of forcing back the fragments, but advocates operation in all cases of fracture within the first twenty-four hours; including even those in the cervical region;" but I would certainly exclude the cervical from the list of operations promising any success.

The preparation for, and the technique of, the operation is important. The patient should be given strychnine freely some hours before, and hypodermics charged with the same should be in readiness for use during its performance.

He should be placed in a semiprone position; hot bottles and warm blankets should be used to keep up body heat and diminish shock. Great care should be observed in giving the anæsthetic, as the position of the patient, and the more or less abdominal paralysis, makes this a most trying procedure, and demands the service of a man who is experienced in administering anæsthetics.

In these cases, all means of reaching the cord rapidly and with safety should be considered; and by this I mean the rapid division of bony structures by strong, sharp rongeurs and forceps.

The greatest danger is *infection* and *sepsis*, which are almost invariably fatal. A free incision should be made down to the bony structure, and the tissues carefully dissected from each side in the manner recommended by Keen; or a horse-shoe flap can be raised, either free or containing the spinous processes, and then the tissues freely separated. The neural arch is exposed, and the lamina severed by a cutting forceps, and further exposure of the canal is readily accomplished by rongeur or laminectomy pliers; usually, extravasated blood will be much in evidence, and continuous irrigation with normal salt solution should be practised.

In badly depressed fractures, the dura mater may be torn, and removal of fragments of bone will show at once the injured cord. If the dura is intact after removal of bone, it

should not be opened, unless there is evidence of blood beneath it. If torn, careful irrigation and exploration of canal and cord should be made, after which the dura may be closed by fine sutures, if practicable, and the whole wound closed tight; or, if drainage is used, it should be of one or two narrow strips of gauze.

The after-treatment is important. There will be considerable oozing, and this will necessitate a change of dressing in twenty-four hours; but after that the wound should not be disturbed oftener than every forty-eight hours, unless the indications point to infection and pus. It is needless to add that strict antisepsis must be observed during the dressing. Careful attention must be paid to the secretions, as they are a fertile source of infection.

The internal administration of strychnine is valuable; absolute quiet must be maintained for some weeks, after which the case will furnish its own indications.

Under antiseptic and aseptic methods the mortality after operation is said to be 60 per cent.; the cases benefited by operation, 25 per cent., and a cure may be expected in about 7 per cent. This percentage of cures should increase with earlier operations. I have had seven cases of undoubted fracture, with three deaths, three greatly benefited, and one cured. The following is a brief account of the last case operated on.

T. S., aged thirty-nine years, while at work in the mines at Hazle Brook, January 17, 1900, was caught by a fall of coal and completely buried beneath the mass. His brother, who worked with him, summoned help, and the coal was removed. The injured man was placed on a train and brought to the hospital in the evening, a few hours after the injury. Examination showed a multiple fracture of the left leg, severe contusion of entire body, and a distinct projection in the dorsolumbar region. Paralysis was absolute from the waist down. Shock was severe, and his general condition serious. He was placed in bed, and the usual preliminary treatment for such cases was given; the fractured leg being placed temporarily in a fracture-box. The next morning he was but little improved, the temperature being sub-

normal. The projection of the spine was very marked and freely movable. I determined to operate at once, and had him prepared and well stimulated. He was etherized and the seat of injury cut down upon. The fracture was indeed severe, the "laminectomy" consisting in merely dissecting away the muscular attachments, when the processes, lamina, and arch of the last dorsal and first lumbar were easily picked up. So severe was the crushing, the spinal canal was filled with blood, which was cleared by irrigation with salt solution; the end of the cord was partially torn; after thorough irrigation and the removal of several spiculae of bone, I closed the wound completely without drainage. The patient was put on an air-bed and the fractured leg put up in plaster. Strychnine was administered from the start, alternating with iodide of potash. Improvement began in four weeks, and the man left the hospital walking with the aid of a cane in July.

At the present writing, August 10, I have under my care a man who was hurt on January 20 of this year, by being caught between a mine-car and a pillar of coal. He was stooping at the time, and was caught while in that position. On admission to hospital, it was found that he had no mark or injury save a decided projection in the dorsal region. Paralysis was absolute. Extension and manipulation were cautiously used, with no result. Operation was then advised and firmly refused. This advice was given repeatedly during the next two weeks, but without avail. He was soon in a pitiable state. He developed two enormous bed-sores, just now about healed. Severe cystitis, requiring daily irrigation, soon followed; at present of little trouble. Sloughing of both heels, marked œdema of thighs and legs, together with involuntary passage of the urine and feces, made a case that was pitiable indeed; and at present he possesses a powerful frame only, covered by atrophied muscles, where a few months ago were 190 pounds of healthy flesh. He now asks for operation, but is not in a condition to warrant it at present. I believe, had he been operated upon shortly after being injured,

his chances for being benefited would have been most excellent.

I have had four other cases of fracture and dislocation of spine, all of them refusing operation, and remaining paralyzed now over two years, and are at present inmates of the poor-house, where they will *exist* perhaps for some years to come. Such as these are cases in which operation will certainly offer the best chances for relief, and without it they are doomed in all probability to a living death.

White's statistics show that thirty-seven operations, performed under strict antiseptis, gave six complete recoveries from operation and injury; six recoveries with benefit; eleven recoveries without benefit, and fourteen deaths. ("American Text-Book," Surgery.)

W. B. Lowman (personal communication) reports seven cases operated upon, with four deaths, two improved, and one with very marked benefit. He believes in the operation, and does it in every case when the patient consents.

Deaver (personal communication) believes the operation justifiable in certain cases. He has operated several times, but has seen little good come from the operation. He further says that it seems to offer the only hope in the majority of cases.

Laplace (quoted from McKenna) reports one operation for severe fracture of dorsal vertebræ, in which several fragments were removed. The result was very marked, and the patient improved rapidly.

Warren (*Boston Medical and Surgical Journal*, May, 1899) reports three cases, all recovered; one was a fibroma of cord; the others for injury.

Davis (*Western Medical Review*) reports one case of fracture. Laminectomy performed with great improvement.

Kramer (*Journal of the American Medical Association*, August, 1900) reports two cases; one in which a thirty-eight calibre bullet entered the abdomen and lodged in the body of the ninth dorsal vertebra, as shown by X-ray. Laminectomy was performed and the ball was removed. Patient succumbed to pyæmia four months later.

The second was a fracture and dislocation of the twelfth

dorsal and first lumbar. Operation three days after injury. Patient improved rapidly, and was able to walk with aid of cane in six months, and to work at his trade (cigar maker).

Munro (*Journal of the Medical Association*, January 6, 1900) reports seventeen cases; eleven died; one relieved for some months; two cured; two improved; one no improvement after eight months.

These operations were on cervical, dorsal, and lumbar vertebræ, and included chronic cases, and also sarcoma of the cord.

Mears (*ANNALS OF SURGERY*, 1899) reports one case of fracture of last dorsal and first lumbar. Laminectomy performed; recovery.

E. Noble Smith (*Lancet*, August 19, 1899) reports a case in which he operated four months after the injury. Cord was compressed by fragments. Bed-sores very extensive. Patient made a rapid recovery.

Scudder (personal communication) "heartily approves of the line of treatment (with the restrictions mentioned) as advocated in this paper." He further says ("Treatise on Fractures"), "Fracture of the arches of the vertebræ, whether open or closed, should be subjected to operation. Fracture and compression of the cauda equina after six weeks of waiting should be treated by operation."

W. L. Rodman (personal communication) reports three operations. One, in which a pistol-shot entered the eleventh dorsal vertebra, completely severing the cord, laminectomy was performed, but the patient was not benefited, as it was six months after the injury before the operation was done. The patient recovered as far as the laminectomy was concerned.

The second case was a boy of sixteen, who had fractured two dorsal vertebræ, and had extensive injury to membranes and cord. He was operated upon shortly after the injury, but succumbed two weeks later from myelitis and meningitis, due to the injury.

The third was a case in which the fracture was high up in the dorsal region. Paraplegia was complete. Operation was performed several months after the injury. The patient recovered and left the hospital very much improved. Rodman states that "when done early, before structural changes occur in the



spinal cord, there is every reason to hope for decided amelioration, if not perfect cure."

Dr. J. C. Biddle, of the State Hospital at Ashland, Pennsylvania, reports thirty cases of fracture dislocations; sixty-six of fractures; twenty-eight of dislocations; forty-eight of partial dislocations; 172 cases in all.

Of the thirty fracture dislocations, twenty-one, or 70 per cent., died, three were cured, five improved, and one unimproved. They were treated 2328 days.

Of the sixty-six fractures, thirty-five, or 53 1-33 per cent., died, seventeen cured, ten improved, and four unimproved. They were treated 6637 days.

Of the twenty-eight dislocations, seven, or 25 per cent., died, eleven cured, eight improved, and two unimproved. They were treated 4199 days.

Of the forty-eight partial dislocations, five, or 10 5-12 per cent., died, twenty-nine cured, twelve improved, and two unimproved. They were treated 4969 days.

Dr. Biddle operated on twenty-nine cases, some immediately, some within a few days, and some from a few weeks to three months after the injury. As he expresses it, he "selected only those cases that seemed hopeless without operation."

I believe he would have had a large number improved, had all been operated upon within forty-eight hours. Of the twenty-nine cases, eighteen died, nine improved, two cured. This gives 31 per cent. of improvement and 7 per cent. cured.

Roberts says ("Modern Surgery"), "Trephining, sawing or cutting away the arches of the vertebrae for the purpose of removing pressure on the spinal marrow, has been attended with some success, and should be adopted more frequently than has heretofore been the case. Operation is always justifiable if the fracture is definitely located, and there is no reason to suspect irremediable displacement."

Golding Bird says, "The hope of restoration of function in those cases in which the cord is not irretrievably damaged depends on the promptitude with which the cause of compression is removed; and however small the number of cases may be in which benefit is to be looked for, even these few justify one in immediate operation."

Keen ("Dennis's Surgery") says, "In an accident, there-

fore, of such gravity, followed by such an immense percentage of deaths, if no operation be done, it would seem to be advisable, with our present experience in all suitable cases, to give patients the real, though often desperate, chance that operation affords; and that the operation should be done at a *much earlier* period and more thoroughly than has hitherto been the rule." (Italics mine.)

To summarize, I would say:

(1) In partial lesions we should operate.

(2) Where the lumbar region is involved with lesions of the cauda equina, operation offers the best chance for recovery.

(3) In fracture of the spinous process, lamina, or entire neural arch, *operation is demanded*.

(4) Should immediate operation not be done, and we wait six to eight weeks, with the result that paralysis of the bladder and bowel continues, with cystitis and severe bed-sores present, we may be sure that nature cannot relieve the case, and an operation is not only indicated, *but demanded*.

[NOTE.—On August 22 I operated upon the case mentioned in this paper, and who was hurt January 20, 1900, and then refused operation. I found a fracture of the tenth and eleventh dorsal vertebra, in which the cord had been compressed since the time of the accident. The separation of the fragments was very difficult, owing to adhesions and callus, and an unusual amount of hæmorrhage, due no doubt to separating the tightly bound ligaments and fragments; the dura was opened and the cord thoroughly irrigated with hot salt solution. There was no pulsation in cord. The wound was closed tightly with deep and superficial sutures. Patient reacted nicely, his temperature has not been elevated since the operation, and his condition is most excellent. What the ultimate outcome will be it is hard to say; but this case certainly demonstrates the need of early operation, and, had this man consented in the beginning, I firmly believe he would be walking to-day, September 10, 1900.]